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OFFICE OF RIVER PROTECTION
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

14-TF-0114

SEP 3 0 2014

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
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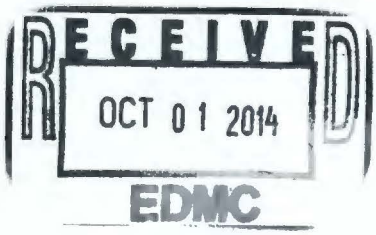

Ms. Hedges:

THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION SUBMITS THE RETRIEVAL COMPLETION CERTIFICATION AND REPORT FOR TANK 241-C-107

References:
1. Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, as amended.

2. Change Notice 2014-02, 2014, "Office of River Protection, State of Washington Department of Ecology Tanks Waste Retrieval Work Plan/ Functions and Requirements Change Notice (Per Hanford Federal Facility Agreement and Consent Order Section 9.3)," RPP-22393, *241-C-102, 241-C-104, 241-C-107, 241-C-108 and 241-C-112 Tanks Waste Retrieval Work Plan*, U.S. Department of Energy, Office of River Protection, Richland, Washington, April 10.

The U.S. Department of Energy, Office of River Protection (ORP), is transmitting RPP-RPT-58150, *Retrieval Completion Certification Report Tank 241-C-107*, Rev. 0, to the Washington State Department of Ecology in accordance with Section IV-B-5 of the Consent Decree in *Washington v. DOE*, Case No. 08-5085-FVS (E.D. Wa. October 25, 2010), which states, "When DOE completes retrieval of waste from a tank covered by this Decree, DOE will submit to Ecology a written certification that DOE has completed retrieval of that tank."

This tank has had three retrieval technologies/systems that were established by Part 1 of RPP-22393, *Tank Waste Retrieval Work Plan*, Rev. 7, via a Hanford Federal Facility Agreement and Consent Order (Reference 1), Change Notice 2014-02, modifying RPP-22393, and approved by Ecology on June 5, 2014 (Reference 2). This letter certifies that ORP has completed retrieval of Tank 241-C-107 in accordance with Part 1 of Appendix C of the Consent Decree.

1226087

If you have any questions, please contact Christopher J. Kemp, Acting Federal Project Director, Retrieval and Closure, at (509) 373-0649.

Kevin W. Smith
Manager

TF:CJK

Attachment

cc w/attach:
TPA Administrative Record
Environmental Portal, LMSI
WRPS Correspondence

cc w/o attach:
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J.J. Luke, WRPS
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ATTACHMENT
14-TF-0114

RPP-RPT-58150
RETRIEVAL COMPLETION CERTIFICATION REPORT FOR TANK 241-C-107
REV. 0

DOCUMENT RELEASE FORM

(1) Document Number: RPP-RPT-58150	(2) Revision Number: 0	(3) Effective Date: 09/22/2014	
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(a) Author (Print/Sign): L. A. Fort L A Fort Date: 9/22/14

(b) Reviewer (Optional, Print/Sign):

R. M. Allen Approved by e-mail Date: 9/18/2014 Date:

T B Mestbold 09/19/2014 Date: Date:

Date: Date:

(c) Responsible Manager – (Print/Sign): S. J. Eberlein Date: 09/19/14

(13) Distribution:

(a) Name	(b) MSIN	(a) Name	(b) MSIN
L. A. Fort	H0-56	J. A. Joyner	R1-51
S. J. Eberlein	H0-55	C. J. Kemp	H6-60
R. M. Allen	S7-83	J. F. Grindstaff	H6-60
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N. R. Davis	H0-55		

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(15) Clearance Review (Print/Sign): APPROVED By Janis D. Aardal at 7:52 am, Sep 22, 2014 Date:

Aardal, Janis D

From: Mesford, Timothy B
Sent: Monday, September 22, 2014 7:38 AM
To: Aardal, Janis D
Subject: FW: Retrieval Completion Certifications

From: Allen, Ruth M
Sent: Thursday, September 18, 2014 5:14 PM
To: Mesford, Timothy B
Cc: Eberlein, Susan J; Wiegman, Rebecca S; Joyner, Jessica A
Subject: Retrieval Completion Certifications

I approve the following Retrieval Completion Certification Reports for release:

- RPP-RPT-58150, *Retrieval Completion Certification Report for Tank 241-C-107*
- RPP-RPT-58140, *Retrieval Completion Certification Report for Tank 241-C-112*

Ruth M. Allen
washington river protection solutions
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Retrieval Completion Certification Report for Tank 241-C-107

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U.S. Department of Energy Contract DE-AC27-08RV14800

EDT/ECN: DRF UC:
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Key Words: Retrieval Completion Certification, single-shell tank, SST, 241-C-107, C-107, double-shell tank, DST, 241-AN-106, AN-106, retrieval, Best-Basis Inventory, BBI, limits of technology, LOT, Mobile Arm Retrieval System, MARS, Tank Waste Retrieval Work Plan, TWRWP, 241-C Tank Farm, C Farm, bismuth phosphate, natrophosphate, sluicing, high-pressure water, hot water dissolution

Abstract: This Retrieval Completion Certification Report documents the completion of retrieval operations on the single-shell tank 241-C-107 on August 7, 2014, using the modified sluicing, high-pressure water, and hot water dissolution technologies as described in the Tank Waste Retrieval Work Plan approved by the State of Washington Department of Ecology on June 5, 2014. This report provides a summary of technical information upon which the decisions to cease tank retrieval operations in tank 241-C-107 were based for each of these technologies. In addition, this report is the mechanism by which the U.S. Department of Energy (DOE) asserts that the selected retrieval technologies have reached their respective limits of technology, in compliance with the requirements of Section IV, Paragraph B.5 of the Consent Decree in Washington v. DOE (Case No. CV-08-5085-FVS) (E.D.Wa. October 25, 2010).

Retrieval Completion Certification Report for Tank 241-C-107

L. A. Fort
Washington River Protection Solutions, LLC

Date Published
September 2014

Prepared for the U.S. Department of Energy
Office of River Protection

Contract No. DE-AC27-08RV14800

Approved For Public Release

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RETRIEVAL COMPLETION CERTIFICATION REPORT FOR TANK 241-C-107

Pursuant to Consent Decree in Case No. CV-08-5085-FVS
(*State of Washington v. Department of Energy* [E.D. Wa. October 25, 2010])

1.0 INTRODUCTION

The U.S. Department of Energy (DOE), Office of River Protection (ORP) is hereby submitting this Retrieval Completion Certification Report (hereinafter "Retrieval Completion Certification") in accordance with Section IV-B-5 of the Consent Decree in *Washington v. DOE*, Case No. CV-08-5085-FVS (E.D. Wa. October 25, 2010) (hereinafter the "Decree" or "Consent Decree"), which provides as follows: "When DOE completes retrieval of waste from a tank covered by this Decree, DOE will submit to Ecology a written certification that DOE has completed retrieval of that tank."

This Retrieval Completion Certification provides a summary of retrieval operations on the single-shell tank (SST) 241-C-107 (C-107) completed on August 7, 2014. Tank C-107 was retrieved using three technologies: modified sluicing, high-pressure water, and hot water dissolution deployed by the Mobile Arm Retrieval System (MARS). The modified sluicing was done with double-shell tank (DST) supernate as described in the Tank Waste Retrieval Work Plan (RPP-22393, *241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan*, Revision 7) approved by the State of Washington Department of Ecology (Ecology). The residual volume in tank C-107 according to RPP-CALC-52903, *Retrieval Performance of Tank 241-C-107 Using the Bulk Mobile Arm Retrieval System*, is a final waste volume of 1,879 ft^3 (14,054 gal). The DOE-ORP recommended deploying a third technology as described in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) (HFFACO) Change Notice 2014-02 modifying Tank Waste Retrieval Work Plan (RPP-22393, Revision 7) and approved by Ecology on June 5, 2014. The three approved retrieval technologies have been deployed to the "limits of technology" as described in Part 1 of Appendix C of the Consent Decree, and therefore no further action is necessary although the resulting residual waste volume did not meet the Consent Decree goal of 360 ft^3.

This Retrieval Completion Certification provides a summary of technical information on which the decisions to cease retrieval operations in tank C-107 were based for the technologies deployed. The format and content of this Retrieval Completion Certification resulted from numerous discussions between Ecology and DOE-ORP and its Tank Operations Contractor, Washington River Protection Solutions, LLC, and an agreed-upon outline that DOE-ORP followed in preparing this document. The DOE-ORP is hereby declaring that it has completed the retrieval of tank C-107 in full compliance with the requirements of Part 1 of Appendix C of the Consent Decree, and with the retrieval technologies/systems that were established by Part 1 of the Tank Waste Retrieval Work Plan, and is submitting this Retrieval Completion Certification accordingly.

2.0 RETRIEVAL PROCESS DESCRIPTION AND CHRONOLOGY

2.1 PRE-RETRIEVAL CONDITION

Tank C-107 is a 530,000-gal SST that has been used to store radioactive waste since April 1946. On the start of retrieval operations, the tank was estimated to contain ~247,000 gal of residual sludge waste and ~6,000 gal of water added during the MARS construction activities. From 1946 until the later part of 1948, the tank received first cycle waste (designated as 1C waste) from B Plant (Bismuth Phosphate process). In 1947, tank C-107 was full and began cascading waste into tank 241-C-108 and tank 241-C-109 with this three-tank cascade series being filled to capacity in 1948. In 1952, with ~496,000 L (131,000 gal) of waste transferred out previously, tank C-107 received uranium recovery tri-butyl phosphate liquid waste until full. In 1956, ~587,000 L (155,000 gal) of waste was transferred out of tank C-107 for cesium scavenging. During 1957 and 1958, 1C waste and numerous line flushes were received. The flush water was generated while clearing a plug in the cascade outlet leading to tank 241-C-108. From 1961 through 1963, the tank received cladding removal waste from the Plutonium-Uranium Extraction (PUREX) facility. From 1964 through 1967, tank C-107 received waste primarily from the Hot Semi-works with additional waste from the CR vault and Site laboratories. In 1970, the tank received waste from tank 241-BX-104, and in 1972 and 1973, the tank exchanged supernatant waste with tank 241-C-104.

Tank C-107 was saltwell pumped in 1976 and 1977. Finally, tank C-107 received strontium-rich sludge in 1977 and was then declared inactive in 1978. Jet pumping campaigns were performed from November 1991 through January 1992 and September 1994 through July 1995 to remove the supernatant and some interstitial liquid. The tank was considered interim stabilized with about 15,000 gal (57,000 L) of pumpable liquid remaining (HNF-SD-RE-TI-178, *Single-Shell Tank Interim Stabilization Record*). Tank C-107 is classified as "sound" (i.e., surveillance data indicates no loss of liquid attributed to a breach of integrity) in HNF-EP-0182, *Waste Tank Summary Report for Month Ending May 31, 2013*, Revision 317. Subsequent re-evaluation of potential leaks and waste losses in 241-C Tank Farm (C Farm) confirmed the sound designation (RPP-ENV-33418, *Hanford C-Farm Leak Assessments Report*).

The chemical and radionuclide composition and inventory of the waste was documented in the Best-Basis Inventory estimate and is based on the results of core samples obtained in 1995 and 2001 and process knowledge of the types of waste that were received at tank C-107 (RPP-RPT-43034, *2009 Auto-TCR for Tank 241-C-107*), and the initial wastes are described and detailed within RPP-RPT-48745, *Best-Basis Inventory for Tank 241-C-107 as of January 1, 2011*.

2.2 PROCESS DESCRIPTION

The solids in tank C-107 were determined to be dominated by Bismuth Phosphate (1C), Strontium recovery, and PUREX cladding waste solids. This composition, unlike many other C Farm tanks, was not considered to be dominated by gibbsite ($Al[OH]_3$) and thus unlikely to

require caustic cleaning for the majority of the waste. Modified sluicing, deployed by use of the MARS, was the first retrieval technology selected and employed in tank C-107, as described (and approved by Ecology) in Revision 5 of RPP-22393 and addressed in RPP-RPT-44139, *Nuclear Waste Tank Retrieval Technology Review and Roadmap*. A high-pressure water system, also deployed by the MARS, was identified as the second technology as described (and approved by Ecology) in Revision 6A of RPP-22393. A third technology of hot water dissolution deployed by the MARS was selected (RPP-PLAN-57604, *Single-Shell Tank 241-C-107 Retrieval Third Technology Selection*) and described in HFFACO Change Notice 2014-02 modifying Tank Waste Retrieval Work Plan (RPP-22393, Revision 7) approved by Ecology on June 5, 2014. The MARS retrieval was established to conduct the waste retrieval primarily through mechanical impact of liquid upon the waste solids resulting in the fluidization and pumped retrieval of the size-reduced material. Supernatant liquor from tank 241-AN-106 (AN-106) and high-pressure water were provided for this hydraulic mining operation (see Revision 7 of RPP-22393).

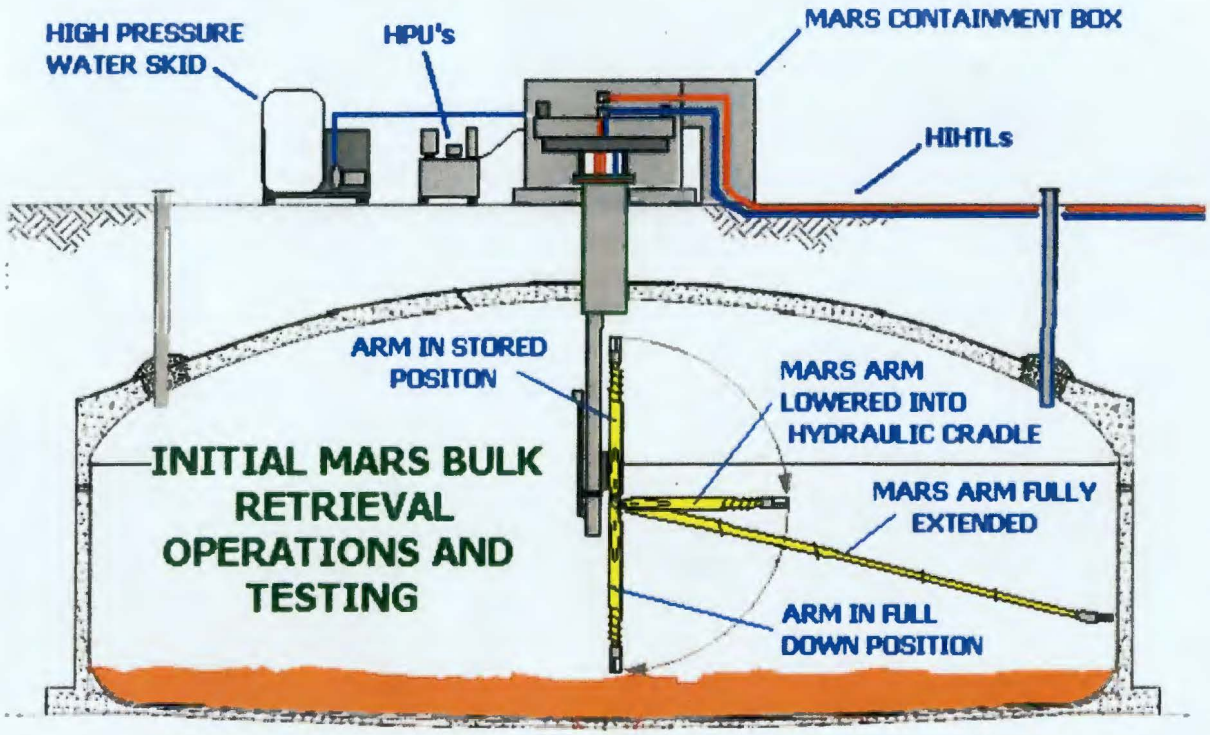
The MARS system is described in RPP-RPT-45704, *MARS Bulk Retrieval System Activity Description*, as well as additional information on the identified 11 subsystems. The MARS arm has an extensive range of motion which allows it to reach to the entire tank bottom as well as the majority of the upper areas of the tank. Supernate from tank AN-106 was used as the sluicing fluid to minimize overall volumetric increase of DST storage. The waste was pumped from tank C-107 to tank AN-106. A closed circuit television was used to provide visual input to direct the sluicing fluid in tank C-107 and to aid the operation of the end-effector. The MARS operations required visual input from the tank C-107 closed circuit televisions.

The MARS bulk retrieval system mobilizes and retrieves waste using spray nozzles at the end of a telescoping arm (in an end-effector) and a centrally located centrifugal slurry transfer pump. The waste was either mobilized with recycled supernate or high-pressure water, or dissolved in hot water. The spray nozzles directed the waste slurry stream toward the center of the tank and the adjustable height slurry transfer pump. The waste was then pumped to tank AN-106. Initially the pump operated with the intake configuration similar to that used in past practice sluicing retrieval operations. Later, during hard heel retrieval operations a pump backstop assembly was lowered around and under the slurry pump. This provided a backstop assembly with support that enabled solid particle size reduction and enhanced fluid velocities into the pump intake for heavy solids entrainment and transport to tank AN-106. A modified slurry distributor installed in tank AN-106 distributed the sludge as it was received from tank C-107. The supernatant pump in tank AN-106 was used to pump liquid to the sluicing nozzles in tank C-107. The pump inlet is at least 18 inches above the slurry distributor. The bulk retrieval mast was installed in the large diameter riser in the center of the tank. Figure 2-1 shows the configuration of the bulk retrieval version of the MARS.

2.3 RETRIEVAL CAMPAIGN CHRONOLOGY

The selected retrieval process of MARS provided multiple technologies for retrieval within one tool set. The MARS end effector had two types of supernate sluicing nozzles as well as high-pressure water nozzles. The slurry pump mast had a re-deployable backstop designed to provide a waste solids collection, suspension, and breakup with high-pressure water nozzles and supernate nozzles within the backstop.

Figure 2-1. Tank 241-C-107 Waste Retrieval System-Bulk Retrieval Operations.



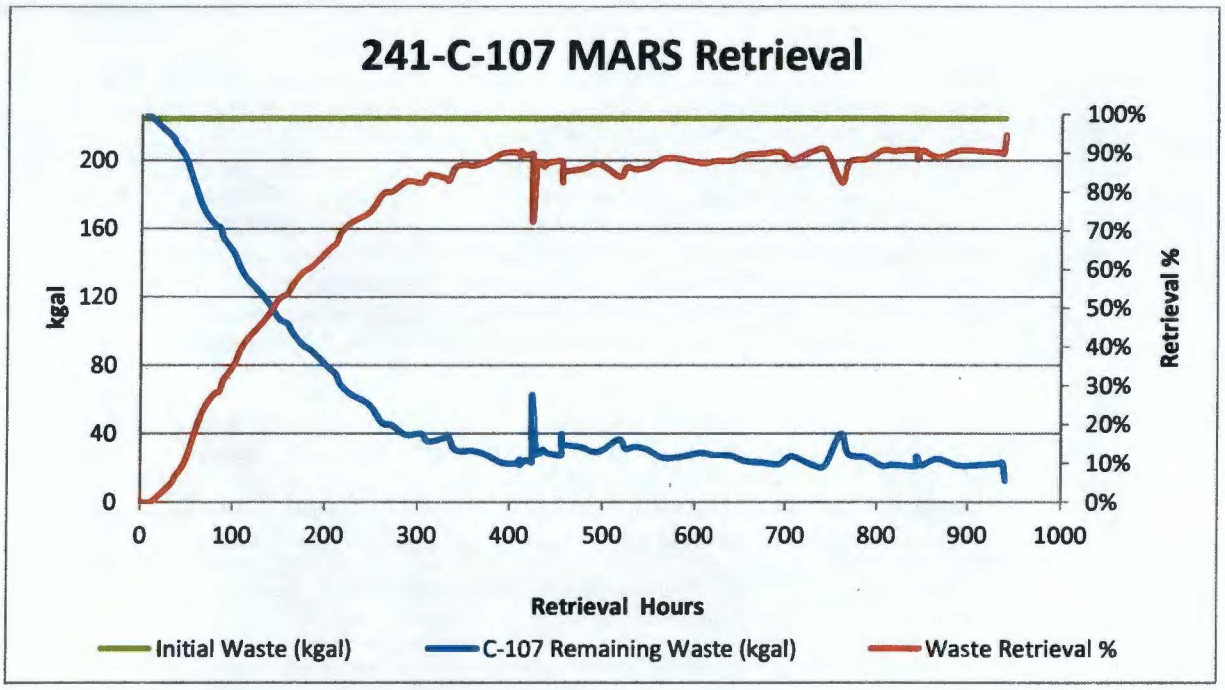
HIHTL = Hose-in-Hose Transfer Line HPU = Hydraulic Pressure Unit MARS = Mobile Arm Retrieval System

Trends and specific operations during the retrieval are depicted in Figure 2-2. The retrieval trend displayed in Figure 2-2 indicates a good retrieval rate to ~450 hours of operations. Upon the failure of the tank C-107 slurry pump, retrieval operations efforts were re-directed by conducting the retrieval of tank 241-C-110 wastes into tank AN-106. Subsequent tank C-107 operations demonstrated no significant performance yields following the introduction of the high-phosphate supernate from tank AN-106 originating from retrieval operations at tank 241-C-110.

Retrieval system performance was tracked by trending the net-waste volume increase in the receiver tank AN-106 after accounting for water additions and adjusting for sludge porosity. This running volume balance does not account for solids dissolution or liquid evaporation. As the volume of waste material received by tank AN-106 approaches the starting waste volume of tank C-107, the estimate of the volume remaining in tank C-107, using the arithmetic difference between these two volumes, becomes increasingly sensitive to uncertainties in the starting waste volume estimate and cumulative measurement uncertainties. The running volume balance and other information were used to generate an estimate of the actual volume of waste retrieved during modified sluicing of tank C-107. An assessment done of two methods used to track progress during the retrieval of tank 241-C-101 to tank 241-AN-101 (RPP-RPT-54839, *Evaluation of the Volumes in Tanks 241-C-101 and 241-AN-101 during Retrieval*) determined that volume is not conserved during retrieval, due to factors that include uncertainties in the

initial volume, the initial waste porosity, the dissolution of solids during waste transfers and the evaporation of liquids during the retrieval and waste transfer process.

Figure 2-2. Tank 241-C-107 Retrieval Performance Trends.



Due to the factors described above, it was determined that there was a significant difference in waste solids residue relative to material transferred (RPP-CALC-52903). As the result of these evaluations, the initial tank C-107 waste volume was corrected by 28,499 gal resulting in a corrected initial inventory of 224,442 gal. Figure 2-2 shows this correction of ~29,000 gal with the impulse rise in remaining waste at 425 hours of slurry transfer.

At the end of sluicing and high-pressure water operations, an estimated ~20,000 gal (9,410 ft^3) of waste remained and ~ 90.9% of the initial waste volume had been retrieved in tank C-107 (RPP-CALC-52903).

Hot water was added (the third technology) to dissolve the sodium fluoride phosphate, sodium aluminate, and sodium phosphate compounds that were present in significant quantities, and to remove other compounds such as the insoluble oxides of uranium, iron, and bismuth; fluorapatite; and sodium aluminosilicate. The hot water was pumped out to tank AN-106.

Table 2-1 provides a chronological summary of the retrieval operations. Retrieval operations were performed between September 27, 2011, and March 28, 2014 using the first and second technologies; and July 21, 2014, and August 9, 2014 using a combination of technologies including the third technology. Retrieval completion percentages used are those corrected for the volumetric displacement inventory corrections of RPP-CALC-52903.

Table 2-1. Retrieval Campaign Chronology. (2 sheets)

Date(s)	Description
September 27 to October 28, 2011	Mobile Arm Retrieval System (MARS) sluicing operations were conducted on eight operating days for a total of 28.3% retrieval in 80.7 hours of slurry transfer. Retrieval was halted by failure of the electric supernatant pump AN06A-WT-P-022 in tank 241-AN-106 (AN-106).
May 23 to August 7, 2012	Following the failure of AN06A-WT-P-022 and the test stand failure of its electric pump replacement AN06A-WT-P-023, hydraulic pump AN06A-WT-P-024 was installed in tank AN-106 allowing return to retrieval. Upon restart, the end effector fan nozzles were plugged with one later returning to operability. On June 13, 2012, retrieval exceeded 58.8% and on July 20, 2012, retrieval achieved 87.8%, allowing declaration of 50% retrieval and declaration of completion of bulk retrieval. This period of MARS sluicing included 34 operating days with 330.5 hours of slurry transfer. Field operations were intermittent in support of tanks 241-C-109 and 241-C-104 waste retrieval operations, determination of a leak at the rotary union in the Containment box, and replacement of Hose-in-Hose Transfer Lines.
August 27 to August 31, 2012	Approximately 10,000 gallons of high-pressure water were used to conduct wall washing after arm software changes were completed to allow high attack of the wastes on the walls and stiffener rings. Because the wall washing resulted in frequent fogging of the tank headspace, visibility inhibited continuous wall clearing. Wall cleaning was discontinued with the failure of one of the four high-pressure water nozzles on the end effector.
September 13, 2012	A total of 13,393 gallons of accumulated wash water and residual supernate was pumped from tank 241-C-107 (C-107) to tank AN-106.
September 19 to September 21, 2012	Retrieval operations resumed briefly but discontinued to troubleshoot issues with tank C-107 pump elevation movement and supernate pump hydraulic power unit fluid losses. Decant of tank AN-106 on September 26, 2012 demonstrated significant hydraulic fluid losses resulting in the loss of the supernate pump. Cumulative slurry transfer totaled 424.5 hours at this point with a corrected retrieval of 89.8% including wall wastes.
May 20 to July 15, 2013	Following replacement of the hydraulic pump AN06A-WT-P-024 with AN06A-WT-P-25, retrieval operations resumed. Initial operations were those of a volume displacement on May 20 to 21. High-pressure water wall washing with 7,670 gallons of water was conducted on July 12, 2013. On July 15 it was determined that the slurry pump in tank C-107 had failed. Cumulative operating days and slurry transfer hours, discounting volumetric displacement, were 54 days and 451.5 hours, respectively, at the end of this period.
January 29 to March 28, 2014	MARS sluicing operations resumed across another 26 sluicing days and 388.5 hours of slurry transfer. 6,300 gallons of high-pressure water were applied at the slurry pump backstop in attempts to break up solids and improve transfer out of the tank. Cumulative sluicing days and slurry transfer hours, discounting volumetric displacement, were 80 days and 840 hours, respectively, at the end of this period. Equipment cleaning and system flushes have introduced approximately 610 gallons of water since March 28, 2014, but no further waste retrieval operations have followed.
July 21 to August 1, 2014	Third Technology retrieval chemical dissolution was conducted with two batched hot water rinses and three batched hot water recirculatory flushes. At the completion of the flushes, the effluent density demonstrated depletion of the water-soluble natrophosphate from the waste solids and re-mobilization of the solids.

Table 2-1. Retrieval Campaign Chronology. (2 sheets)

Date(s)	Description
August 3 to August 7, 2014	Four days of continuous operation of supernate-based sluice retrieval were conducted with an aggregate of 86.3 hours of sluicing and 82 hours of slurry transfer. These operations from 1:00 a.m. on August 3 through 5:00 a.m. on August 7 transferred 458,840 gallons of sluice material and returned 460,200 gallons of slurry. No net sludge transfer was evidenced.
August 7, 2014	Final volumetric displacement was conducted, importing supernatant liquid from tank AN-106, and returning it to tank AN-106, with Honeywell Enraf* measurements taken of both tank AN-106 and tank C-107.
August 9, 2014	Final water rinse of waste residuals was conducted with 16,018 gallons admitted to tank C-107 and 13,998 gallons received in tank AN-106. The water rinse was conducted as a continuous dilution of interstitial and pooled liquid.

*Honeywell Enraf® is a registered trademark of Honeywell International Inc., Corporation Delaware, 101 Columbia Road Morristown, New Jersey.

As evidenced by final waste volume displacements, less waste is present than estimated by transfer. Based upon the initial inventory, final waste volume displacement and final rinse, and wall estimates, the residual waste is assessed as 14,054 gal (1,879 ft^3) and 93.74% net retrieval as of August 9, 2014 (RPP-CALC-52903).

2.4 LIMIT OF TECHNOLOGY

According to RPP-50910, *Single-Shell Tank Waste Retrieval Limit of Technology Definition for Modified Sluicing*, meeting the following two criteria constitutes reaching the "limit of technology" for retrieval of waste from a Hanford Site SST using modified sluicing with only DST supernate or water as the sluicing medium.

1) The concentration of SST waste in the retrieved slurry sent to the DST is within or bracketing a 0 to 0.6 vol. percent range for three operating periods. Bracketing refers to two successive data points, one of which is below 0 and the next near or above 0.6, which average less than 0.6 vol. percent. An operating period is a period over which retrieval performance is measured. An operating period is normally one operating day, but as a minimum must be greater than or equal to 8 hours in duration and consist of at least ~10,000 gal (~1,340 ft^3) of slurry transferred from the SST.

2) The DOE-ORP and the Tank Operations Contractor have provided documentation to Ecology that demonstrates that all reasonable efforts were attempted to enhance the effectiveness of the installed modified sluicing retrieval system in order to increase waste removal from all quadrants of the tank under consideration.

Modified sluicing and high-pressure water retrieval operations were performed from September 27, 2011 to March 28, 2014 in tank C-107. Figure 2-2 shows the retrieval system performance (volume of waste retrieved as a function of the volume of slurry, i.e., solids plus recycled tank AN-106 supernate, transferred from tank C-107 to tank AN-106). A retrieval

performance summary was conducted at the end of March 2014 and those retrieval performance values are displayed in Table 2-1. Table 2-2 includes all tank C-107 retrieval operating times during the date period shown.

Table 2-1. Hard Heel Limited Retrieval Operations Assessment for Tank 241-C-107.

Retrieval Start	Date	3/16/2014	3/25/2014	3/26/2014	3/27/2014
	Time	16:05	16:30	12:32	12:30
Retrieval End	Date	3/17/2014	3/26/2014	3/27/2014	3/28/2012
	Time	20:26	9:48	5:30	22:22
Sluicing Duration	HH:mm	16:49	12:48	14:54	11:43
Slurry Transfer Duration	HH:mm	17:42	11:31	15:02	11:27
Sluice Volume	gallons	79,754	62,862	73,031	55,051
Slurry Volume	gallons	85,400	63,071	74,028	56,786
Start Enraf®*	inches	241.43	243.05	242.83	243.06
End Enraf®*	inches	243.27	242.83	243.06	243.11
Net Enraf®* change	gallons	5,060	(605)	632	193
Prior Date Total Waste Transfer to Date	gallons	198,540	203,600	202,995	203,628
New Total Waste Transfer to Date	gallons	203,600	202,995	203,628	203,820
Prior Minimum Residual Floor Waste	gallons	21,085.0	20,842	20,842	20,814
New Residual Floor Waste	gallons	20,841.5	21,447	20,814	20,621
Daily Sludge Transfer	gallons	244	0	27	193
Sludge/Sluice	Vol %	0.31%	0.00%	0.04%	0.35%

*Honeywell Enraf® is a registered trademark of Honeywell International Inc., Corporation Delaware, 101 Columbia Road Morristown, New Jersey.

Source: RPP-RPT-54959, *Single-Shell Tank 241-C-107 Hard Heel and Third Technology Retrieval Completion Report.*

As shown in Table 2-1, more than three periods of normal MARS operations exhibited tank waste concentrations less than 0.6% exceeding the criteria of one shift and 10,000 gal of sluicing. These conditions demonstrate the limit of technology for MARS in sluicing and high-pressure water retrieval operations (normal) of tank C-107.

The third technology retrieval operations, in August 2014, demonstrated a consistently low waste retrieval recovery rate. Table 2-2 details retrieval operations showing the limits of the third technology.

With the retrieval assessment detailed in Table 2-2, more than three periods of MARS operations exhibited tank waste concentrations less than 0.6% exceeding the criteria of one shift and 10,000 gal of sluicing. These conditions show that the limit of technology has been

demonstrated by hot water dissolution (the third technology) deployed by MARS in tank C-107 waste retrieval operations.

Table 2-2. Third Technology Limited Retrieval Operations Assessment.

Retrieval Start	Date	8/3/2014	8/3/2014	8/5/2014	8/6/2014
	Time	1:05	19:59	4:25	4:20
Retrieval End	Date	8/3/2014	8/5/2014	8/6/2014	8/7/2014
	Time	19:59	4:25	4:20	4:10
Sluicing Duration	HH:mm	18:55	24:26	21:35	21:23
Slurry Transfer Duration	HH:mm	16:54	22:21	21:09	21:26
Sluice Volume	gallons	95,427	155,632	105,025	102,760
Slurry Volume	gallons	92,580	159,654	105,585	102,384
Start Enraf®*	inches	246.43	245.07	246.46	246.37
End Enraf®*	inches	245.07	246.46	246.37	246.06
Net Enraf®* change	gallons	-3,740	3,823	-248	-853
Prior Date Total Waste Transfer to Date	gallons	203,275.2	199,535	203,358	203,110
New Total Waste Transfer to Date	gallons	199,535.2	203,358	203,110	202,258
Prior Minimum Residual Waste	gallons	20,621.5	20,621	20,621	20,621
New Residual Waste	gallons	24,906.3	21,084	21,331	22,184
Daily Sludge Transfer	gallons	0	0	0	0
Sludge/Sluice	Vol %	0.00%	0.00%	0.00%	0.00%

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Source: RPP-RPT-54959, *Single-Shell Tank 241-C-107 Hard Heel and Third Technology Retrieval Completion Report.*

A final water rinse of the tank was conducted on August 9, 2014. The objective of the rinse was to remove soluble supernate-based contaminants from the SST. In this operation, the design of the MARS allowed a continuous rinse and dilution rather than batched dilutions. The operation is detailed in RPP-CALC-52903; 16,018 gal were used in the rinse and 13, 998 gal were transferred to tank AN-106, leaving 2,020 gal of water in tank C-107.

All reasonable efforts to enhance the effectiveness of the sluicing/high-pressure water/water dissolution process were made. Following the water washes, the third technology retrieval activities returned to supernate-based sluicing. Although such operations showed that the wastes were re-mobilized, the particle size remained too large to be picked up and passed through the pump screen. Based on the performance metrics evaluated with the implementation of these technologies and consideration of the factors specified in the Consent Decree, DOE-ORP has concluded that the retrieval technologies were deployed to the limit of technology at tank C-107.

Per the Consent Decree, the limits of technology should consider risk reduction, facilitating tank closures, costs, the potential for exacerbating leaks[1], worker safety, and the overall impact on the tank waste retrieval and treatment mission.

- The modified sluicing had effectively removed the bulk of the sludge, and little or no additional waste could be retrieved by continued deployment, resulting in little or no additional reduction of risk. The MARS performed as designed.

- The hot water dissolution retrieval had further broken up the waste heel and allowed some additional waste retrieval, but was not fully changing the remaining waste to a form that could be suspended and pumped. Hence, it had reached the point where little or no additional waste could be retrieved by continued deployment, resulting in little or no additional reduction of risk.

- Continued retrieval operations at tank C-107 would result in continued exposure to workers. Although retrieval operations are controlled from a control trailer, multiple field activities (exhauster filter changes, valve line-ups, field measurements and monitoring, etc.) are required to support the retrieval operations, resulting in continued exposure.

- Continued retrieval operations at tank C-107 would increase schedule duration, with the potential to affect other retrieval activities and therefore the overall retrieval and treatment mission.

- Continued retrieval operations at tank C-107 would incur costs without an associated risk reduction.

As a result, DOE-ORP concluded that sluicing, high-pressure water and chemical retrieval (hot water dissolution) retrieval processing had been deployed to the limit of the technologies.

Improvements implemented during the retrieval of the tank C-107 waste include the following.

- MARS Arm software was changed to allow high attack of the wastes on the walls and stiffener rings. Previous interlocks had inhibited operation with the arm higher than ~8° below the horizontal plane.

- Commonality of pump design and procurement aided more rapid deployment following the loss of the tank AN-106 electric supernate pump and its spare. The supernate pump was replaced with a pump procured for slurry operations and then replaced shortly thereafter following failure in September 2012. The same pump design was employed to replace the slurry pump in tank C-107 upon its failure in July 2013.

- Inadvertent disengagement of remote operation of a flow control valve during maintenance within the Portable Instrument and Valve Box POR240, and failure of the

[1] Tank C-107 is not an assumed leaker, so the potential for exacerbating leaks was not considered significant.

remote operation of another flow control valve (fan nozzle supply) within POR240, demonstrated that the control assembly of the flow control valves should be established outside of the shielded valve boxes. This design improvement has been applied in the MARS Vacuum process.

- Recovery of chemical precipitation agglomeration was demonstrated with third technology retrieval activities. Hot water rinses and hot water recirculatory flushes were employed to remobilize waste solids agglomerated by precipitation of saturated natrophosphate in the supernate of tank AN-106. The water rinses and flushes were further used to dilute the supernate within tank AN-106 in order to inhibit repetition of natrophosphate precipitation.

- Final tank waste water rinses were configured, through procedural and MARS-S Arm use, to conduct continuous dilution rinsing of residual waste rather than batched dilution. This configuration reduced expected rinsing operating durations from three days to one shift and waste generation and transfer to tank AN-106 from ~78,000 gal to 14,000 gal. These work reduction and waste generation reduction techniques will be applied, as available, in future retrievals.

3.0 POST-RETRIEVAL CONDITIONS

Several methods (i.e., volume displacement, video observations, and engineering judgment) were used to estimate the waste volume removed and the residual waste volume left after each retrieval phase. A complete discussion of these methods and associated calculations of the estimated waste volume removed from tank C-107 during the three retrieval phases (modified sluicing, high-pressure water, and hot water technologies) is documented in RPP-RPT-54959, Revision 1, and RPP-CALC-52903, Revision 3. The bulk of the remaining waste is located in the non-pumpable heel volume and composed of rinse waters and low profile, gravel-like masses covering the tank floor. Figure 3-1 shows tank C-107 after waste retrieval operations.

The initial Best-Basis Inventory waste volume for tank C-107 was estimated at ~247,000 gal (~33,000 ft^3) at the start of retrieval (RPP-RPT-43034) and subsequently corrected to ~224,400 gal (~30,000 ft^3) (RPP-CALC-52903, Revision 3). The amount of waste remaining in tank C-107 after waste retrieval operations were completed was estimated to be ~14,000 gal (~1,880 ft^3) (see RPP-CALC-52903, Revision 3). A future Camera/Computer-Aided Design Modeling System analysis will provide final waste volume estimates.

Figure 3-1. Tank 241-C-107 Photo Mosaic at End of Retrieval Operations.

4.0 RETRIEVAL COMPLETION SUMMARY AND CONCLUSIONS

At the conclusion of the third technology waste retrieval operations, hot water dissolution deployed by the MARS, tank C-107 contained ~14,000 gal (~1,880 ft^3) of waste (see RPP-CALC-52903, Revision 3). The bulk of the remaining waste is located in the non-pumpable heel volume and composed of sluice waters and low profile, gravel-like masses covering the tank floor. Some larger reef-like waste solids are distributed around the haunch of the tank. The estimated residual waste volume on the walls and stiffener rings comprise 23% of total waste residual estimates. Following dissolution of natrophosphate crystallization which inhibited transfer, the remaining residual wastes are non-pumpable and cannot be mechanically reduced in size. Due to the reduced waste retrieval rate, it was determined that the MARS technologies could not remove any more waste from tank C-107.

5.0 CONCLUSION

This summary report supports DOE's written certification that DOE has completed retrieval of tank C-107 in accordance with Part 1 of Appendix C of the Consent Decree (*Washington v. DOE*, Case No. CV-08-5085-FVS [E.D.Wa. October 25, 2010]) with DOE deploying the three retrieval technologies that were established by approval of Ecology on June 5, 2014, in HFFACO Change Notice 2014-2, modifying Tank Waste Retrieval Work Plan RPP-22393, Revision 7.

Retrieval operations were performed with the MARS employing supernate sluicing, high-pressure water (including wall washing), and backstop deployment with supernate. The retrieval was further performed with chemical dissolution in the form of hot water dissolution of natrophosphate crystallization and further supernate sluicing to the limits of the technologies deployed.

The format and content of this Retrieval Completion Certification summary follows a general outline that was developed collaboratively by Ecology and DOE-ORP in a series of meetings held between December 19, 2011 and March 6, 2012. A working version of this outline was accepted in a February 9, 2012 meeting between DOE-ORP and Ecology.

6.0 REFERENCES

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